

Polarised parton distributions *

D.de Florian, L.N.Epele, H.Fanchiotti, C.A.García Canal, R.Sassot

Laboratorio de Física Teórica
Departamento de Física
Universidad Nacional de La Plata
C.C. 67 - 1900 La Plata
Argentina

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Abstract

We analyze spin dependent parton distributions consistent with the most recent measurements of the spin dependent deep inelastic scattering structure functions and obtained in the framework of the spin dilution model. Predictions for the doubly polarised proton-proton Drell-Yan asymmetry, for the high p_T photon production mechanism and J/Ψ excitation are calculated using these distributions and are shown to be particularly adequate to unveil the polarisation of partons in the proton.

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I. Introduction:

Recently the SMC collaboration at CERN has reported on a measurement of the proton polarised asymmetry in deep inelastic scattering of polarised muons off polarised hydrogen [1]. This measurement was meant to corroborate and extend the controversial data produced by EMC in 1988 [2] on the first moment of the proton spin dependent structure function g_1^p

$$\Gamma_1^p|_{EMC} = \int_0^1 g_1^p dx = 0.126 \pm 0.010(stat.) \pm 0.015(sys.) \quad (1)$$

which has been interpreted as an important contribution to the structure function either from the polarisation of gluons, of the strange quarks or of both.

Notwithstanding the new results for the asymmetry confirm those of the previous measurement, the new values taken at small x differ with the extrapolations assumed in [2] yielding for the moment of the spin dependent structure function

$$\Gamma_1^p|_{SMC} = 0.136 \pm 0.011(stat.) \pm 0.011(sys.) \quad (2)$$

to be compared with Eq.(1). Part of the difference is also due to the fact that g_1^p is obtained from the measured asymmetry $A_1^p(x, Q^2)$ through

$$xg_1^p(x, Q^2) = \frac{A_1^p(x, Q^2)F_2^p(x, Q^2)}{2(1 + R(x, Q^2))} \quad (3)$$

and they have used a recent parametrization [3] for the spin independent structure function $F_2^p(x, Q^2)$ which has a better accuracy at low x .

The rise in the value of the moment together with the fall in the theoretical expectation for the quark contribution to the moment, resulting from the new values for the F and D parameters [4], reduces considerably the amount of gluon or strange quark polarisation needed to understand the data. This situation forces an update of the parametrizations of quark and gluon spin dependent distributions and also a reconsideration of the experiments meant to size the gluon and strange quark polarisation.

In this paper we present two new sets for the quark and gluon spin dependent distributions obtained including the recent SMC data on the proton in the fitting procedure. One with an important net gluon polarisation and another in which this polarisation is negligible. Both are constructed in the framework of the spin dilution model [6-7] and are in agreement with all the available deep inelastic scattering polarised asymmetries [2],[8-10]. The main features of the valence quark, sea quark, and gluon distributions in both sets are discussed. The low x behaviour of the asymmetries and structure functions resulting from the distributions is analyzed and special emphasis is given to the comparison between this behaviour and those

assumed in the extrapolation of the measured data. These extrapolations are key ingredients in the estimation of the moments Γ_1^p , Γ_1^n , and Γ_1^d .

Up to now, different experiments have been proposed in order to discriminate between the alternative of a large net gluon polarisation in the proton and an important contribution from the strange quarks [10]. Predictions are made using different sets of distributions. In section III we calculate cross sections for the doubly polarised proton-proton Drell-Yan asymmetry, for the high p_T photon production mechanism and J/Ψ excitation using our updated sets and compare them with previous results. In so doing, we find that not all the proposed mechanisms are actually able to discriminate between the different scenarios.

We also comment on the correct implementation of the factorization scheme in the use of the polarised distributions. This has not been taken into account in some proposals and is shown to ruin the alleged discriminative power of some experiments.

Finally, we show that certain experiments, suitably combined, can give additional information such as the way in which the spin is distributed among the different flavours in the sea. This information is clearly beyond the scope of DIS measurements and has to be guessed in any spin dependent parametrization, nevertheless is an important ingredient in the knowledge of the proton structure.

II. Spin-dependent parton distributions:

In the recent years, the increased precision and variety of data yielded by unpolarised lepton-hadron and hadron-hadron experiments has considerably improved our knowledge of parton distributions in the proton. Nowadays, extremely precise unpolarised parton distributions are extracted from global fits with a decreasing number of model assumptions about them. The situation, however, is quite different for the spin dependent parton distributions for which the data is comparatively scarce. The main experimental input available for the extraction of the spin dependent parton distributions, $\Delta q_i(x, Q^2)$ and $\Delta G(x, Q^2)$, are the spin dependent structure functions $g_1^N(x, Q^2)$ which are now known for the proton, the neutron and the deuteron. The relation between parton distributions and structure functions depends on the factorization scheme chosen to define the former. In what follows we shall adopt the one in which the distributions are related to the structure functions by [11]

$$g_1^p(x, Q^2) = \frac{1}{2} \sum_i e_i^2 \Delta q_i(x, Q^2) - \frac{\langle e_i^2 \rangle}{2} \frac{\alpha_s}{2\pi} n_f \Delta G(x, Q^2) \quad (4)$$

and not the DIS like scheme [12], labeled by a caret, where

$$g_1^p(x, Q^2) = \frac{1}{2} \sum_i e_i^2 \Delta \hat{q}_i(x, Q^2) \quad (5)$$

The relationship between them is simply given by

$$\Delta q(x, Q^2) = \Delta \hat{q}(x, Q^2) + \frac{\alpha_s}{4\pi} \Delta G(x, Q^2) \quad (6)$$

where Δq is related to the conserved part of the axial current. The expression for $g_1(x, Q^2)$ is known up to order α_s .

As the present information is not enough to determine individually the distributions, it is imperative to make some assumptions about them. For this we follow the main lines of the spin dilution model [5], implemented as in reference [6], which relates the spin dependent quark and gluon distributions with the corresponding spin independent distributions by means of spin dilution function. This function is fixed in order to satisfy the constraints on the polarised distributions for $x \rightarrow 0$ and $x \rightarrow 1$ leaving a few parameters to be adjusted. Doing this, the full information about the unpolarised parton distributions and the constraints on the polarised ones are taken into account.

Let us obtain different sets of spin-dependent quark and gluon distributions compatible with the deep inelastic scattering polarised asymmetries available at the moment. To this end we follow the procedure suggested in ref. [6] which consists in fixing the free parameters of the spin dilution model in the two following ways.

i) In this first set (LP1), the disagreement between the Ellis-Jaffe sum rule prediction [13] for Γ_1^p

$$\Gamma_1^p |_{Ellis-Jaffe} = \frac{F+D}{12} \left[\left(1 - \frac{\alpha_s}{\pi}\right) + \frac{1}{3} \frac{3F/D-1}{F/D+1} \left(5 - \frac{\alpha_s}{\pi} (1 - 4C_F)\right) \right] = 0.1766 \pm 0.006 \quad (7)$$

and the experimental value Eq.(2) is ascribed, as it is commonly accepted [11], to the anomalous gluon contribution to g_1^p

$$\Delta \Gamma_1^{gluon} = \int_0^1 dx \frac{\langle e_i^2 \rangle}{2} \frac{\alpha_s}{2\pi} n_f \Delta G(x) \quad (8)$$

which means

$$\Gamma_1^p |_{Ellis-Jaffe} - \Delta \Gamma_1^{gluon} = \Gamma_1^p |_{SMC} \quad (9)$$

and implies

$$\Delta \Gamma_1^{gluon} = 0.040 \quad (10)$$

As we have previously mentioned, this value is considerably lower than the one obtained in ref. [6] because of the new values for Γ_1^p found by SMC and the most recent hyperon

β -decay data [4] parametrized in terms of F and D . Once the spin dilution parameter for the gluon is fixed in order to satisfy Eq.(7), the other parameters of the model are fixed just to reproduce the known asymmetries and the quantities $F + D$ and F/D .

ii) Another extreme situation is given by the second set (LP2), in which $\Delta\Gamma_1^{gluon}$ is forced to be zero. In this set, the discrepancy is ascribed to a negative polarisation in the strange quark sea, namely

$$\Delta\Gamma_1^s = \frac{1}{3}(1 - \frac{\alpha_s}{\pi}C_F) \int_0^1 dx \Delta s \quad (11)$$

fixed by

$$\Gamma_1^p |_{Ellis-Jaffe} + \Delta\Gamma_1^s = \Gamma_1^p |_{SMC} \quad (12)$$

This equation forces the strange quark contribution to be negative at variance with those of the non strange sea quarks, which in the framework of the spin dilution model are assumed to be radiatively generated from the valence quarks and thus positive. The implications of this will be addressed in the next section.

Figures (1-3) show the asymmetries for proton, neutron and deuteron as calculated with set LP1 against the measured values. The second set yields similar results for the asymmetries. Table (1) shows the spin dilution model parameters for both sets coming from a global fit to all the available data using the set MRSD_ given in reference [14], which agree with the most recent HERA results, for the unpolarised parton distributions. The parameters are fixed for $Q^2 = 10 \text{ GeV}^2$ assuming the values obtained for the asymmetries are valid at that scale. We also have evolved the parametrizations using spin dependent Altarelli-Parisi evolution equations obtaining asymmetries with a very mild Q^2 dependence, as it was reported in the experimental analysis of the data. A Fortran subroutine that gives the resulting spin dependent parton distributions is available upon request*.

Parameter	Set LP1	Set LP2
$a_{u_v,0} = a_{\bar{u}}$	0.150	0.170
$a_{u_v,1}$	0.013	0.003
$a_{d_v,0} = a_{\bar{d}}$	0.600	0.600
$a_{d_v,1}$	0.100	0.100
$a_{\bar{s}}$	$10a_{\bar{u}}$	0.050
a_g	0.055	—

Table 1.

*DEFLO@venus.fisica.unlp.edu.ar

Table (2) compares the χ^2 values obtained with different sets. It is clear from the table that it is not possible to discriminate between our sets using only polarised deep inelastic scattering data. The parametrizations taken from references [15] and [16] contain both a large amount of gluon polarisation and were proposed before the recent data and reanalysis were published, nevertheless they yield sensible χ^2 values. It is worth noticing that a half of the total χ^2 in our sets comes from the comparison with SMC proton data at values of x not very small, where the sets give good account of the other experiments.

Experiment	N ⁰ of data	χ^2			
		LP1	LP2	Ref.[15]	Ref.[16]
E80 A_1^p	4	1.43	1.53	3.56	2.78
E130 A_1^p	8	3.43	3.41	13.12	4.45
EMC A_1^p	10	3.94	3.89	8.64	9.50
SMC A_1^d	11	5.65	5.60	4.63	5.41
E142 A_1^n	8	3.27	3.38	5.86	5.42
SMC A_1^p	12	22.98	20.89	22.33	32.52
Total	53	40.07	38.07	58.14	60.08

Table 2.

In Table (3) we show values for the moments Γ_1 obtained integrating the distributions together with those reported by the experimental collaborations (assuming an extrapolation for the low x contributions), and the sum rule expectations (corrected because of the anomaly).

	Experimental Data	Sum rule prediction	Parametrizations			
			LP1	LP2	Ref.[15]	Ref.[16]
$\Gamma_1^p - \Gamma_1^n$	SMC+EMC 0.204 ± 0.029	0.193	0.194	0.194	0.205	0.210
Γ_1^d	SMC 0.023 ± 0.020	0.035	0.034	0.037	0.033	0.030
Γ_1^p	SMC 0.136 ± 0.011	0.136	0.135	0.137	0.139	0.139
Γ_1^n	E142 -0.031 ± 0.011	-0.056	-0.059	-0.057	-0.066	-0.071
F/D	0.573 ± 0.01	-	0.577	0.576	0.578	0.549
$F + D$	1.257 ± 0.003	-	1.265	1.265	1.357	1.375

Table 3.

The only line for which there seems to be a disagreement between our sets and the quoted experimental values is the one for Γ_1^n . As our sets give a good account of E142 data, the

discrepancy seems to lay in the small x behaviours assumed (higher twists are negligible at $Q^2 = 10 \text{ GeV}^2$ where the analysis is performed). In the case of E142 data, the extrapolation begins at a rather high value of x , ($x = 0.03$), so the difference can be substantial. This is in fact the case, as it is shown in Table (4) where the contributions from the unmeasured regions are tabulated.

	Value from extrapolation	From parametrizations	
		LP1	LP2
$\Gamma_1^p - \Gamma_1^n _{x < 0.006}$	SMC+EMC 0.007 ± 0.007	0.008	0.010
$\Gamma_1^d _{x < 0.006}$	SMC -0.003 ± 0.003	-0.006	-0.003
$\Gamma_1^n _{x < 0.03}$	E142 -0.009 ± 0.006	-0.031	-0.030
$\Gamma_1^p _{x < 0.003}$	SMC 0.004 ± 0.002	-0.002	0.002

Table 4.

There is a significant difference between the value coming from the extrapolation assumed by E142 and those produced by the behaviour of the distributions in our sets. We remind the reader that this behaviour, in the spin dilution model, depends on three factors; the actual behaviour of the unpolarised parton distributions, the constraints on the spin dependent distributions, and the parameters fixed by the available data, which include the lower x data of the other experiments.

Between the two sets there is a slight difference arising from the dominance of either the gluons or the sea quarks, illustrated by the low x contribution to the proton moment. This contribution is negative in the LP1 set (dominated by gluons) whereas is positive in the LP2, where a conspiracy between the sea contributions yields the result.

Summarizing this section, we conclude that it is possible to build sensible spin dependent parton distributions compatible with all polarised deep inelastic scattering experiments. Allowing certain degree of gluon or strange quark polarisation, considerably smaller than originally thought, the distributions are also compatible with the Bjorken and Ellis-Jaffe sum rules and β -decay data. The alleged discrepancy between the different experiments, and also between experimental results and sum rule predictions, is shown to be due to the inconsistent way in which the data is extrapolated to small x . Deep inelastic scattering experiments are not, however, able to discriminate between sets with gluon or sea quark polarisation. In the next section we show that the discrimination can be done measuring spin-spin asymmetries in polarised proton-proton collisions.

III. Spin-spin asymmetries:

Several processes in which, in principle, the sea quark and gluon polarisation can be extracted directly from experiment have been suggested since the so called proton spin crisis began [10]. In this section we compare predictions for heavy quark pair production, direct photon production at large p_T and Drell-Yan processes in polarised proton-proton collisions coming from sets of spin dependent quark and gluon distributions with different assumptions about the polarisation of sea quarks and gluons. As these processes are much more sensitive to the sea quark and gluon distributions than deep inelastic scattering, they will be able to complement the information obtained up to now.

We begin considering the Drell-Yan proton-proton polarised asymmetry defined by

$$A_{LL}^{DY} = \frac{d\sigma^{\uparrow\uparrow}/dQ^2 - d\sigma^{\uparrow\downarrow}/dQ^2}{d\sigma^{\uparrow\uparrow}/dQ^2 + d\sigma^{\uparrow\downarrow}/dQ^2} \quad (13)$$

where $d\sigma^{\uparrow\uparrow}$ ($d\sigma^{\uparrow\downarrow}$) denotes the cross section for the configuration where the incoming proton spins are parallel (antiparallel), and Q^2 is the invariant mass squared of the outgoing lepton pairs.

It has been suggested [16] that this asymmetry is particularly useful to discern between a large gluon polarisation and a large polarisation of the sea quarks. The argument given in reference [16] for this is that A_{LL}^{DY} , calculated with a set of parton distributions where the sea is negatively polarised, is positive whereas, when calculated using a set with large gluon polarisation, is negative. It is, then, just a question of measuring the sign of this asymmetry to ascribe the defect in $\Gamma_1^p|_{EMC-SMC}$ either to Δs or ΔG .

Performing the computations with our sets we find, however, that the Drell-Yan experiment is unable to discriminate between the two different scenarios. The difference in signs obtained in reference [16] is just a consequence of having mixed different factorization schemes in the analysis. On one side they use a cross-section defined for a DIS scheme-like distribution [12], however their distributions are extracted in the Altarelli-Ross scheme [11]. Using the relation between both schemes given in Eq.(12), it is straightforward to write the Drell-Yan cross section in the AR scheme

$$\begin{aligned} \frac{d\Delta\sigma^{DY}}{dQ^2} = & -\frac{4\pi\alpha^2}{9sQ^2} \int_0^1 \frac{dx_1}{x_1} \int_0^1 \frac{dx_2}{x_2} \sum_i \left\{ \left[e_i^2 \Delta q^i(x_1, t) \Delta \bar{q}^i(x_2, t) + (1 \leftrightarrow 2) \right] \right. \\ & \times [\delta(1-z) + \theta(1-z)\alpha_s \Delta w_q(z)] + (e_i^2 [\Delta q^i(x_1, t) + \Delta \bar{q}^i(x_1, t)] \\ & \times \Delta G(x_2, t) + (1 \leftrightarrow 2)) \left. \left[-\frac{\alpha_s}{4\pi} \delta(1-z) + \theta(1-z)\alpha_s \Delta w_G(z) \right] \right\} \quad (14) \end{aligned}$$

where

$$\begin{aligned}\Delta w_q(z) &= \frac{4}{6\pi} \left[\left(1 + \frac{4}{3}\pi^2\right)\delta(1-z) + \frac{3}{(1-z)_+} + 2(1+z^2) \left[\frac{\log(1-z)}{1-z} \right]_+ - 4 - 2z \right] \\ \Delta w_G(z) &= \frac{1}{4\pi} \left[(2z-1)\log(1-z) - \frac{3}{2}z^2 + 3z - \frac{1}{2} \right]\end{aligned}\quad (15)$$

and

$$z = \frac{\tau}{x_1 x_2} = \frac{Q^2}{sx_1 x_2} \quad (16)$$

This cross section has an extra “delta function” term proportional to the polarised gluon distribution which makes the quark and gluon next to leading order term to be equally important. In Figures (4) and (5) we compare the A_{LL}^{DY} calculated as in reference [16] with the corrected predictions. Both Figures correspond to $\sqrt{s} = 27 \text{ GeV}$. The correction changes the sign of the asymmetry in the gluonic scenario and is relatively small for the other at values of Q^2 not very high. The correction clearly reduces the differences between the predictions coming from the two scenarios.

There exist also an ambiguity related to the way the spin is distributed among the flavours of the sea which reduces also the discriminative power of the experiment the gluon-strange quark alternatives but allows another application. In the sets proposed in reference [16] the sea polarisation is $SU(3)$ invariant ($\Delta u = \Delta d = \Delta s$). Another possibility, implemented in our sets, is that the non strange sea is polarised parallel to the net valence polarisation and only the the strange quarks became negatively polarised (in set 2). Predictions for A_{LL}^{DY} using our sets are shown in Figure (6). There is a negligible difference between the predictions of both sets due not only to the fact that in the new sets the gluons or the strange quarks are less polarised but to the fact that the Drell-Yan asymmetry picks also (and prevailingly) the non strange sea. We therefore conclude that this asymmetry can not tell us whether gluons contribute to g_1^p or not but can discriminate between an $SU(3)$ symmetric sea ($A_{LL}^{DY} > 0$) and one where this symmetry is broken ($A_{LL}^{DY} < 0$).

Another candidate for probing the sea and gluon polarisation is the direct photon production in proton-proton collisions [17]. At parton level, and to the lowest order, prompt photons are produced via Compton scattering $qG \rightarrow \gamma q$ and annihilation $q\bar{q} \rightarrow \gamma G$. In the leading order, the differential cross section reads

$$\begin{aligned}E_\gamma d^3\Delta\sigma/dp_\gamma^3 = & \frac{\alpha_{em}\alpha_s}{s} \int_{x_{min}}^1 dx_1 \frac{1}{x_1 x_2 (x_1 s + u)} \left[\sum_i^{n_f} e_i^2 [\Delta q_i(x_1, Q^2) \Delta \bar{q}_i(x_2, Q^2) + (1 \leftrightarrow 2)] \frac{d\Delta\hat{\sigma}}{d\hat{t}}(q\bar{q} \rightarrow \gamma G) \right. \\ & \left. + 2g_1(x_1, Q^2) \Delta G(x_2, Q^2) \frac{d\Delta\hat{\sigma}}{d\hat{t}}(qG \rightarrow \gamma q) + 2\Delta G(x_1, Q^2) g_1(x_2, Q^2) \frac{d\Delta\hat{\sigma}}{d\hat{t}}(qG \rightarrow \gamma q) \right] \quad (17)\end{aligned}$$

where

$$\begin{aligned}
\frac{d\Delta\hat{\sigma}}{d\hat{t}}(q\bar{q} \rightarrow \gamma G) &= -\frac{8}{9}\left[\frac{\hat{t}}{\hat{u}} + \frac{\hat{u}}{\hat{t}}\right] \\
\frac{d\Delta\hat{\sigma}}{d\hat{t}}(qG \rightarrow \gamma q) &= -\frac{1}{3}\left[-\frac{\hat{t}}{\hat{s}} + \frac{\hat{s}}{\hat{t}}\right] \\
\frac{d\Delta\hat{\sigma}}{d\hat{t}}(Gq \rightarrow \gamma q) &= -\frac{1}{3}\left[-\frac{\hat{u}}{\hat{s}} + \frac{\hat{s}}{\hat{u}}\right]
\end{aligned} \tag{18}$$

and

$$\hat{s} = x_1 x_2 s, \quad \hat{t} = x_1 t, \quad \hat{u} = x_2 u \tag{19}$$

The cross section has been calculated up to two loops in references [18] [19] in different factorization schemes. There, it has been shown that the resulting corrections for the corresponding asymmetry are small.

The asymmetries calculated with our two sets at $\sqrt{s} = 100 \text{ GeV}$ and $p_T = 5 \text{ GeV}$ are shown in Figure (7). In this case we find a clean difference between the prediction of both sets. As the Compton subprocess dominates over the annihilation one, this experiment avoids, up to a certain extent, the ambiguity related to the way in which the sea is polarised.

Heavy quark production in polarised proton-proton collisions is another experiment dominated by gluon-gluon fusion and, consequently, can corroborate the extraction of ΔG coming from the previous one. Following reference [20], we calculate the J/Ψ production two spin asymmetry

$$A_{LL}^{J/\Psi} = \frac{d\sigma_{\uparrow\uparrow}/d^3p - d\sigma_{\uparrow\downarrow}/d^3p}{d\sigma_{\uparrow\uparrow}/d^3p + d\sigma_{\uparrow\downarrow}/d^3p} = \frac{Ed\Delta\sigma/d^3p}{Ed\sigma/d^3p} \tag{20}$$

where

$$E \frac{d\Delta\sigma}{d^3p} = \frac{1}{\pi} \int_{x_1^{min}}^1 dx_1 \Delta G(x_1, Q^2) \Delta G(x_2, Q^2) \left(\frac{x_1 x_2}{x_1 - \frac{e^y}{\sqrt{s}} \sqrt{m_{J/\Psi}^2 + p_T^2}} \right) \frac{d\Delta\hat{\sigma}}{d\hat{t}} \tag{21}$$

$$E \frac{d\sigma}{d^3p} = \frac{1}{\pi} \int_{x_1^{min}}^1 dx_1 G(x_1, Q^2) G(x_2, Q^2) \left(\frac{x_1 x_2}{x_1 - \frac{e^y}{\sqrt{s}} \sqrt{m_{J/\Psi}^2 + p_T^2}} \right) \frac{d\hat{\sigma}}{d\hat{t}} \tag{22}$$

$$\tag{23}$$

and $d\hat{\sigma}/d\hat{t}$ is the differential cross section for the subprocess $GG \rightarrow J/\Psi G$, using sets LP1 and LP2. Figure (8) shows the prediction computed at $\sqrt{s} = 20 \text{ GeV}$, $y = 0$, as a function of p_T . For the kinematical range $1 < p_T < 6 \text{ GeV}$ the predictions differ substantially and can be eventually discriminated. For higher values of p_T both sets yield similar results being the cross section dominated by gluons coming from the Q^2 evolution.

We conclude this section pointing up how polarised proton-proton collisions would be able to test the assumptions made in the previous section providing valuable pieces of information about polarised parton distribution.

The J/ψ production asymmetry is proportional to the gluon spin-dilution function squared so it not only measures the net gluon polarisation ΔG but the explicit x dependence, which is assumed in the fits. The Drell Yan asymmetry tells us whether the SU(3) symmetry in the sea is a good approximation or not, yielding constraints on the x dependence and normalization of the polarised sea distributions. Finally, direct photon production, being proportional to the products of valence quark and gluon spin-dilution functions and valence quarks and sea quarks in different kinematical regions, allows a cross check for the information obtained from all the above mentioned polarised experiments.

IV. Conclusions:

Recent data on proton polarised asymmetry in deep inelastic scattering reported by the SMC collaboration indicate a substantial reduction in the amount of gluon or strange quark polarisation needed to bring agreement between the Ellis-Jaffe prediction for Γ_1^p and its experimental value. This reduction has important consequences in the obtention of spin dependent parton distributions, which inevitably includes assumptions on the size of these quantities, and the feasibility of some experiments intended to measure them.

In this paper we have constructed two different sets of parton distributions in the framework of the spin dilution model with the amount of gluon or strange quark polarisation suggested by the most recent experiments. We have analysed the consequences of this reduction in the global fit of spin dependent data finding a mild improvement but not significative. We also have examined predictions for three different polarised proton-proton collision cross sections concluding that whereas the Drell-Yan spin-spin asymmetry is not a good test to see whether the gluons or the strange quarks contribute dominantly, prompt photon and J/Ψ production in proton-proton collisions can measure the size of the gluon polarisation.

References

- [1] SM Collab., B.Adeva et al., CERN-PPE/94-57 (1994)
- [2] EM Collab., J.Ashman et al., Phys.Lett.B206, (1988), 364.
- [3] NM Collab., P.Amaudruz et al., Phys.Lett.B295, (1992), 159 and CERN-PPE/92-124 (July 1992); Errata Oct.26, (1992) and Apr.19, (1993).
- [4] Z.Dziembowski and J.Franklin, Nucl.Part.Phys.17, (1991), 213.
- [5] R.Carlitz, J.Kaur, Phys.Rev.Lett.37, (1976), 673;
A.Schäfer, Phys.Lett.B208, (1988), 175;
R.M.Woloshyn, Nucl.Phys.A496, (1989), 749.
- [6] D.de Florian et al., Phys.Lett.B319, (1993), 285.
- [7] M.J. Alguard et al., Phys.Rev.Lett.37, (1976), 1261; 41, (1978), 70.
G.Baum et al., Phys.Rev.Lett.45, (1980), 2000; 51, (1983), 1135.
- [8] SM Collab., B.Adeva et al., Phys.Lett.B302, (1993), 533.
- [9] E142 Collab., P.L.Anthony et al., SLAC-PUB-6101, (1993).
- [10] E.Reya DO-TH 92/17 (1992) and references therein.
- [11] G.Altarelli, G.G.Ross, Phys.Lett.B212, (1988), 883.
- [12] P.Ratcliffe, Nucl.Phys.B223, (1983), 47.
- [13] J.Ellis, R.L.Jaffe, Phys.Rev.D9, (1974), 1444; Erratum Phys.Rev.D10, (1974), 1669.
- [14] A.D.Martin, R.G.Roberts and W.J.Stirling, Phys.Lett.B306, (1993), 145.
- [15] K.Sridhar, E.Leader, Phys.Lett.B295, (1992), 283.
- [16] Hai-Yang Cheng, Sheng-Nan Lai, Phys.Rev.D41, (1990), 91.
- [17] E.L.Berger, J.W.Qiu, Phys.Rev.D40, (1989), 788.
- [18] L.E.Gordon, W.Vogelsang, Phys.Rev.D49, (1994), 170.
- [19] A.P.Contogouris et al., Phys.Lett.B304, (1993), 329.
- [20] T.Morii, S.Tanaka, T.Yamanishi, Phys.Lett.B322, (1994), 253.

Figure Captions

- Figure 1 The spin-dependent proton asymmetry given by the model (set LP1) compared to SMC [1], EMC [2] and earlier SLAC data [7].
- Figure 2 The same as Figure (1) but for the spin-dependent neutron asymmetry given by E-142 [9].
- Figure 3 The same as Figure (1) but for the spin-dependent deuteron asymmetry given by SMC [8].
- Figure 4 The Drell-Yan spin-spin asymmetry as calculated in reference [16] and corrected.
- Figure 5 The Drell-Yan spin-spin asymmetry calculated with sets LP1 and LP2.
- Figure 6 The direct photon spin asymmetry calculated with sets LP1 and LP2.
- Figure 7 The J/Ψ production two spin asymmetry calculated with sets LP1 and LP2.

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